

An aerial photograph of a suburban neighborhood with several houses, a winding road, and parking lots. A large red diagonal shape covers the right side of the image, serving as a background for the text.

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2024 Heat Pump Efficiency &
Performance Webinar



Agenda

- ✓ Introductions
- ✓ CPAU Electrification Program
- ✓ HVAC Review
- ✓ Heat Pump Operating Principles
- ✓ Overview of Heat Pumps
- ✓ Efficiency, Savings, and Rebates
- ✓ Heat Pumps Benefits and Challenges
- ✓ Q&A

Speaker

- Steve Brennan; CLEAResult Engineering Manager



About the City of Palo Alto Utilities (CPAU)

- Municipally owned utility in the City of Palo Alto
- Approximately 30,000 customers
- 6 utilities, over 120 years of history
- 80% below 1990 levels by 2030 emissions reduction goals through the City's Sustainability and Climate Action Plan



Water (1896)



Wastewater (1898)



Electric (1900)



Gas (1917)



Storm Drain (1898*)



Fiber (1996)

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CPAU Programs



BUSINESS ENERGY ADVISOR
CITY OF PALO ALTO

Business Energy Advisor

- Free energy assessment and ongoing project support
- Generous rebates for water conservation and energy efficiency projects
- Available to businesses under 50,000 square feet

Business Electrification Technical Assistance

- Free electrification assessment and ongoing technical assistance with projects
- Rebates for electrification projects like heat pump water heaters and heat pump packaged units

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CPAU ELECTRIFICATION PROGRAM



CPAU Electrification Rebates

BUSINESS CUSTOMER REBATES CATALOG
MAY 2022



ELECTRIFICATION REBATES

CPAU encourages our business customers to replace natural gas-fired equipment with efficient electric alternatives. Electrification of gas equipment lowers the building's greenhouse gas emissions and also helps to improve regional air quality.

Product Code	Equipment	\$Rebate/Unit	Eligibility Requirements
BE01	Electrification - packaged or split system heat pump	\$650/ton	• Must replace an existing less efficient packaged or split AC and natural gas furnace. The existing furnace equipment must be removed and disposed of rather than refurbished and sold. • Existing gas line(s) serving removed gas equipment must be capped off and removed refrigerant must be handled and disposed in accordance with all state and local regulations including but not limited to the California Building Energy Efficiency Standards (Title 24) and the Appliance Efficiency Regulations (Title 20), the California Building Standards Code, the California Plumbing Code, and the National Electrical Code (NEC). • The packaged or split heat pump must meet the minimum efficiency requirements: • Less than 65,000 BTUH: minimum 15 SEER and 8.2 HSPF • 65,000 to 134,000 BTUH: minimum 14 IEER and 3.4 COP • Greater than 134,000 BTUH: please apply for a "Custom Rebate" (see page 16). • The following information must be submitted: 1. Did the site require any electric infrastructure upgrades for the proposed electrification measure? If yes, provide the itemized invoices with infrastructure upgrade costs. 2. Please provide a photo(s) of the nameplate of installed equipment
BE02	Electrification - heat pump water heater (HPWH) 45 - 55 gallons	\$2,500	• Must replace an existing gas tank water heater • New heat pump water heater must meet the uniform energy factors (UEF) based on the storage capacity listed below: • 45 to 55 gallons: minimum 3.31 UEF • 55.1 to 75 gallons: minimum 3.33 UEF • Greater than 75 gallons: minimum 3.42 UEF • The following information must be submitted: 1. Did the site require any electric infrastructure upgrades for the proposed electrification measure? If yes, provide the itemized invoices with infrastructure upgrade costs. 2. Please provide a photo(s) of the nameplate of installed equipment
BE03	Electrification - HPWH 55.1 - 75 gallons	\$3,000	
BE04	Electrification - HPWH ≥ 75.1 gallons	\$3,500	



CPAU Electrification Rebates

BUSINESS CUSTOMER REBATES CATALOG
MAY 2022



ELECTRIFICATION REBATES

Product Code	Equipment	\$Rebate/Unit	Eligibility Requirements
BE05	Electrification - fryer	\$5,000	• Must replace an existing gas equivalent. • Electric fryers must meet ENERGY STAR® Version 3.0 specifications. • Convection oven must meet ENERGY STAR® Version 2.2 specifications. • The following information must be submitted: 1. Did the site require any electric infrastructure upgrades for the proposed electrification measure? If yes, provide the itemized invoices with infrastructure upgrade costs. 2. Please provide a photo(s) of the nameplate of installed equipment
BE06	Electrification - convection oven • Half size	\$1,200	
BE07	Electrification - convection oven • Full size	\$2,500	

CUSTOM ELECTRIFICATION REBATES

Custom electrification rebates are available for projects that do not qualify for prescriptive electrification rebates. This incentive is open to technologies such as heat pump pool heaters, heat recovery chillers as well as customer processes that are currently fueled by natural gas. The rebate is calculated based on the net energy savings using this equation: $[Net\ kWh-e] = [kWh_gas_1] + [kWh_elec_1] - [kWh_electric_2]$

Where:

$[kWh_gas_1]$ = Annual gas energy used by the existing gas equipment converted from therms to kWh using the conversion factor of 29.3

$[kWh_elec_1]$ = Annual electric energy used by the existing equipment in kWh

$[kWh_elec_2]$ = Annual electric energy used by the proposed electric equipment in kWh

$[Net\ kWh-e]$ = Annual net energy savings in kWh

Custom electrification rebates are offered at \$0.25/kWh-e.

To be eligible for custom electrification rebates, the measure(s) should conform to the following rules:

- The measure or project must eliminate natural gas usage.
- The measure or project must not be based on behavioral changes.
- The calculation of net energy savings (kWh-e) must be stamped by a professional engineer licensed in the State of California in an applicable discipline.
- A Measurement and Verification (M&V) Plan should be written and agreed upon by all parties. Rebate disbursement is contingent upon the successful execution of the M&V plan.
- All projects must be pre-approved to be eligible for incentives.
- Projects receiving electrification incentives are not eligible for energy efficiency incentives or rebates.
- Incentives are capped at 50% of the project cost, or \$100,000, whichever is less.

Application Process

- Please refer to the application process under "Custom Rebates" on page 15.



Audit vs Electrification Measures

Measure Name	Category
Combination Oven	Commercial Kitchens
Kitchen Demand Control Ventilation	Commercial Kitchens
Steam Cooker	Commercial Kitchens
Holding Cabinet	Commercial Kitchens
EC Motors on Refrigeration Fans	Commercial Refrigeration
Other Water Measures	Custom
Convection Oven	Commercial Kitchens
Ice Machine	Commercial Refrigeration
Fridge or Freezer	Commercial Refrigeration
Fryer	Commercial Kitchens
Griddle	Commercial Kitchens
Air Side Econo	Cooling Efficiency
HVAC Unit Replacement	Cooling Efficiency
DCV - interior	Cooling Efficiency
Case Doors	Commercial Refrigeration
Dishwasher	Commercial Kitchens
Vending Machine	Commercial Refrigeration
LED Lighting	Lighting
Anti-Sweat Heaters	Commercial Refrigeration
VFD on Motor	Motors and Drives
VFD on CWP	Motors and Drives
Water Heater	Water Heating Efficiency

Measure Name	Category
Aerator	Water Heating Efficiency
Convection Oven	Commercial Kitchens
Fryer	Commercial Kitchens
Case Doors	Commercial Refrigeration
Dishwasher	Commercial Kitchens
Pipe Insulation	Heating Efficiency
Combination Oven	Commercial Kitchens
Kitchen Demand Control Ventilation	Commercial Kitchens
Steam Cooker	Commercial Kitchens
Griddle	Commercial Kitchens
Steam Trap	Heating Efficiency
Sprayer	Commercial Kitchens
Ozone	Heating Efficiency
RCx	RetroCommissioning

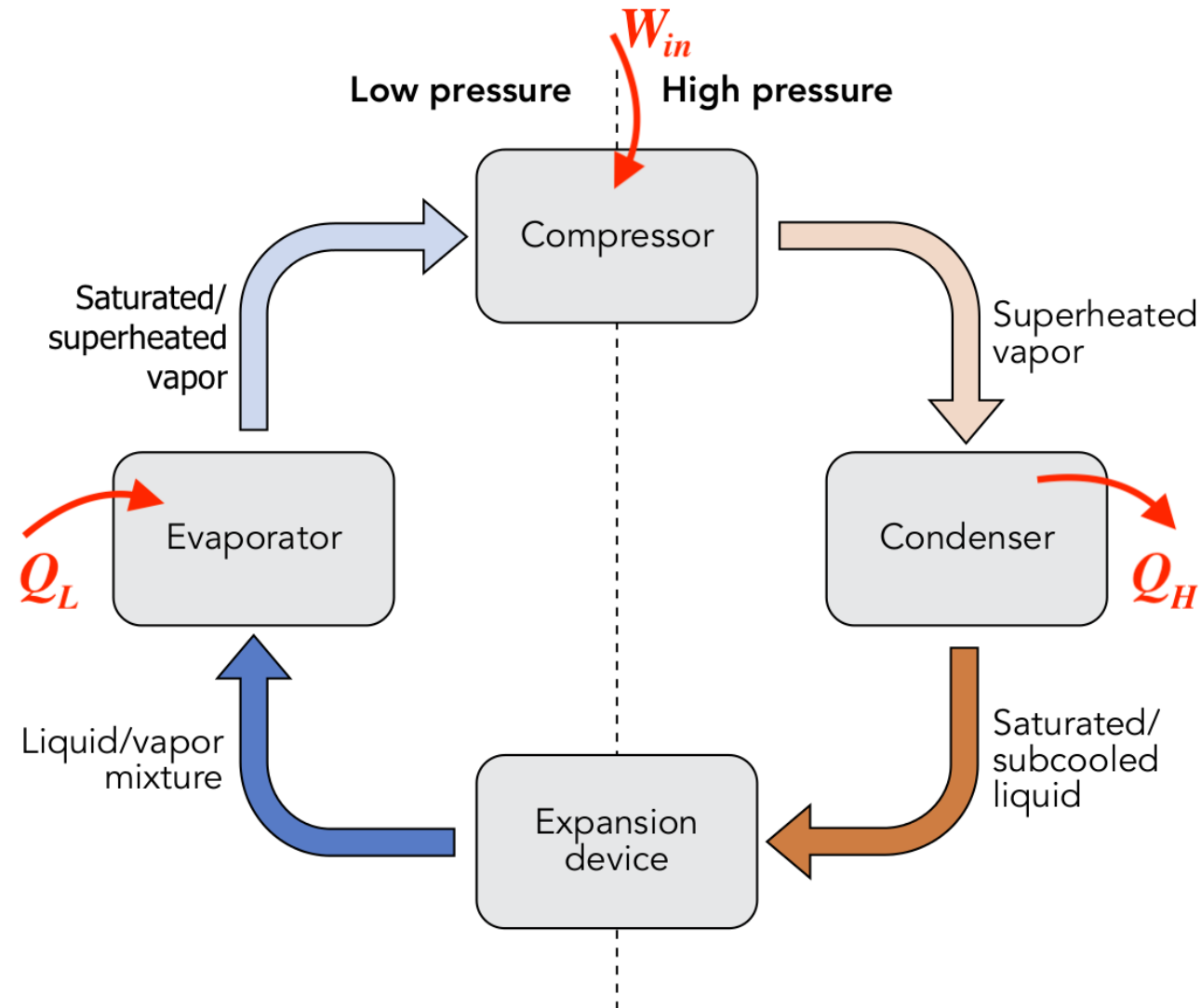
Measure Name	Category
Heat Pump Water Heater	Commercial Kitchens
Convection Oven	Commercial Kitchens
Fryer	Commercial Kitchens
Package Heat Pump	Cooling Efficiency
Custom 1	Custom

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HVAC REVIEW

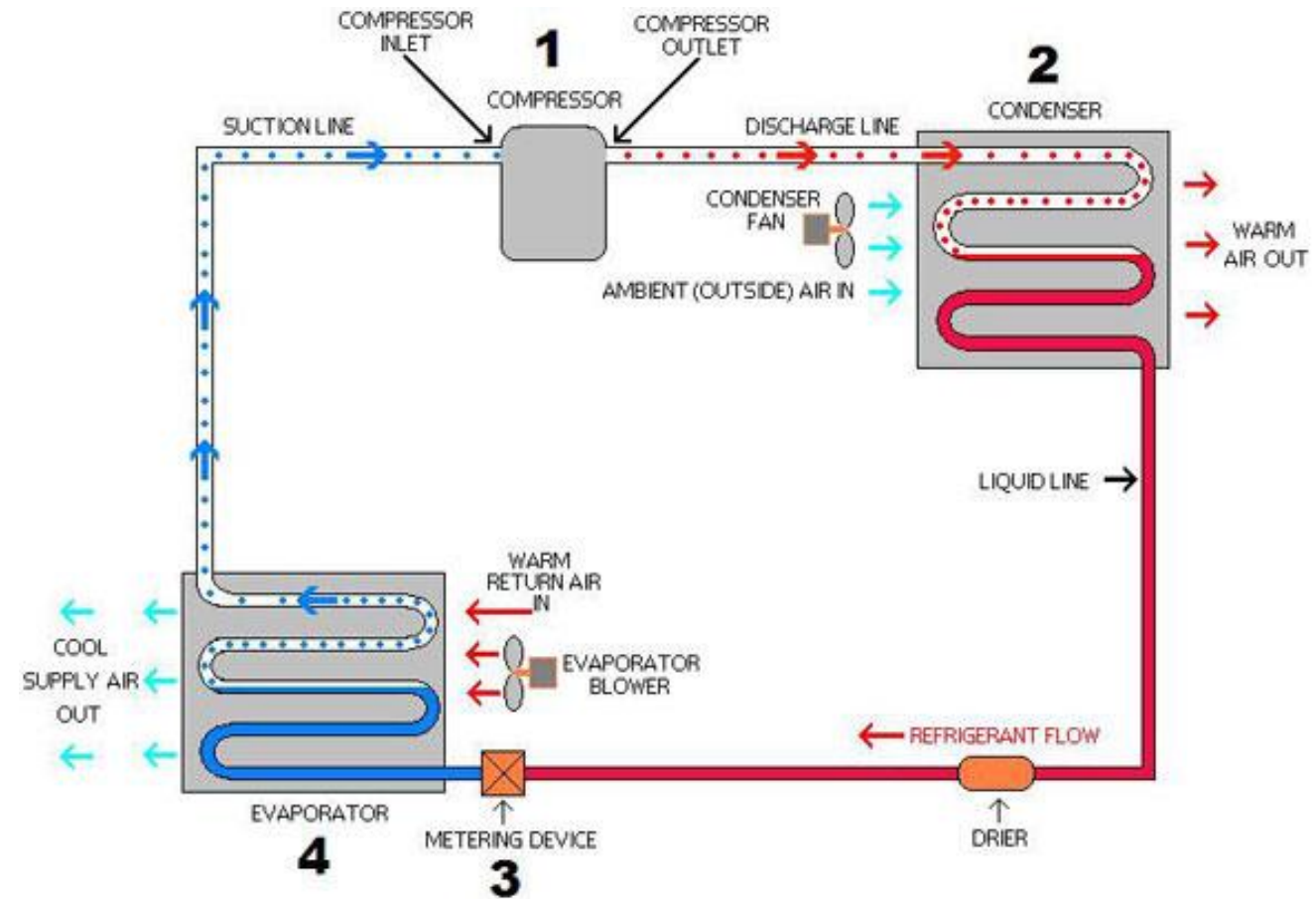
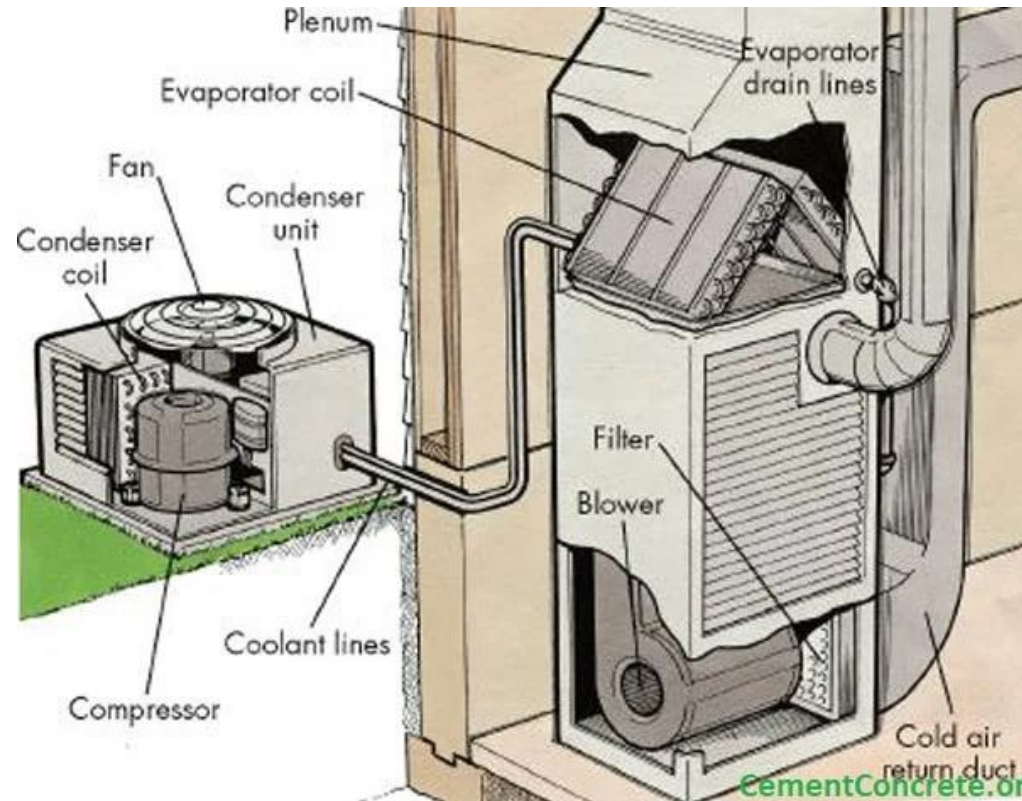


Refrigeration Cycle



Understanding HVAC system components and operation

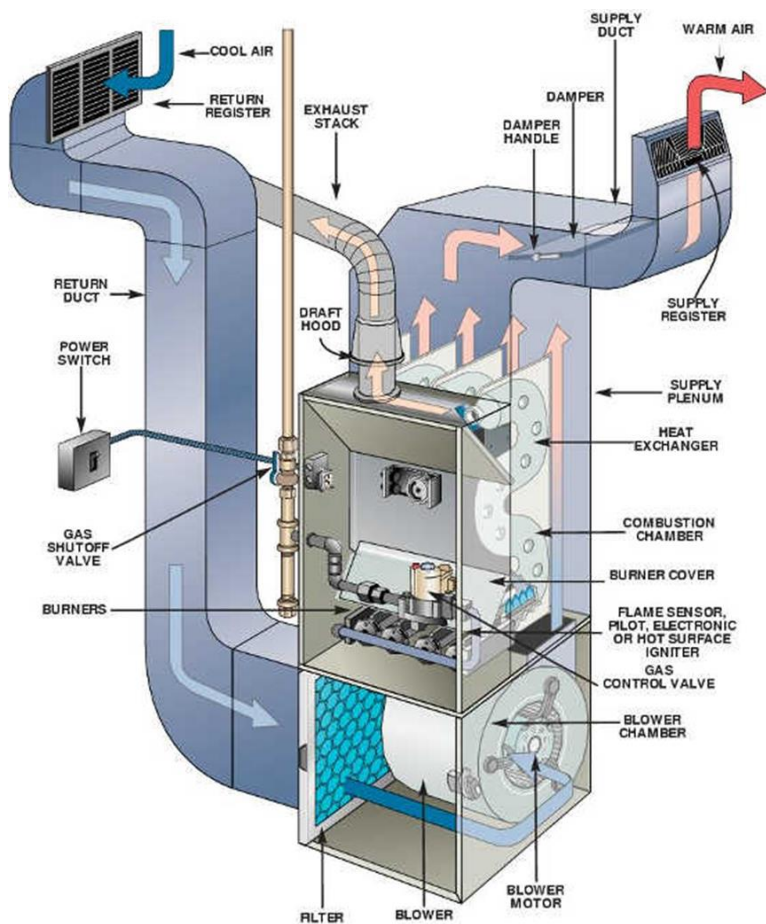
Split AC Systems





Understanding HVAC system components and operation

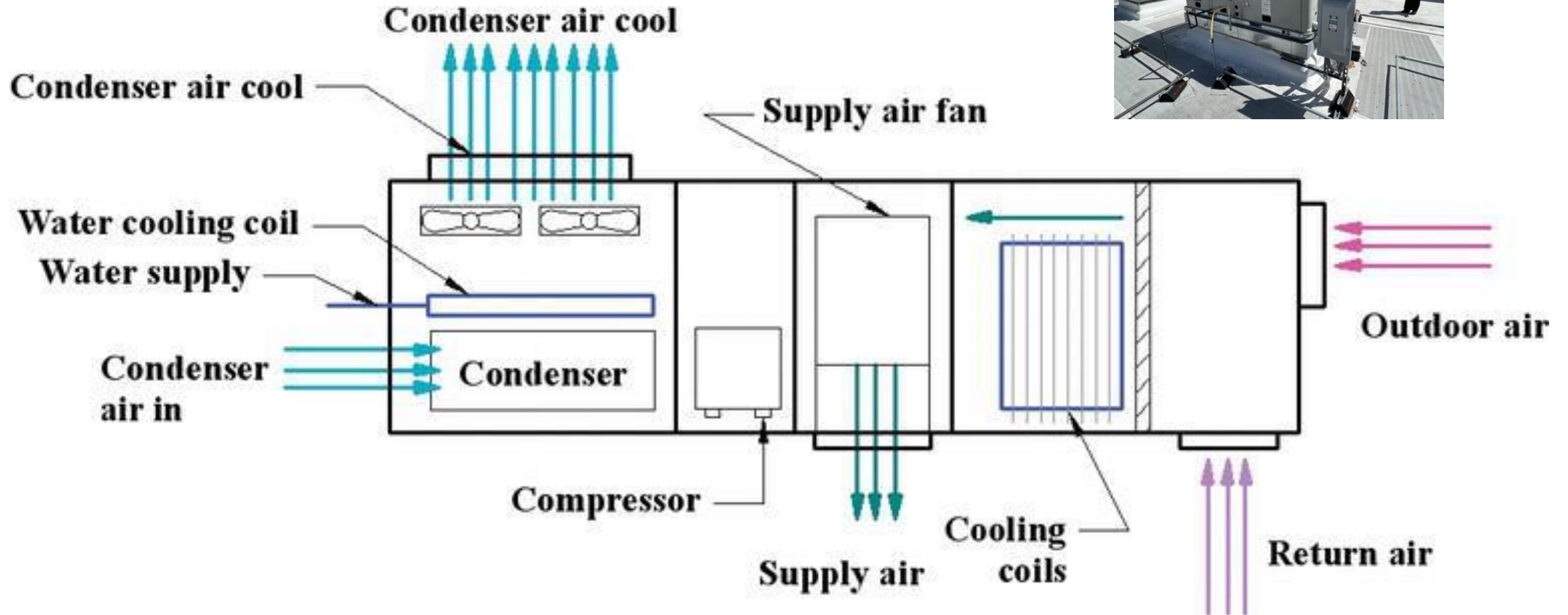
Split AC Systems





Understanding HVAC system components and operation

Package AC Systems





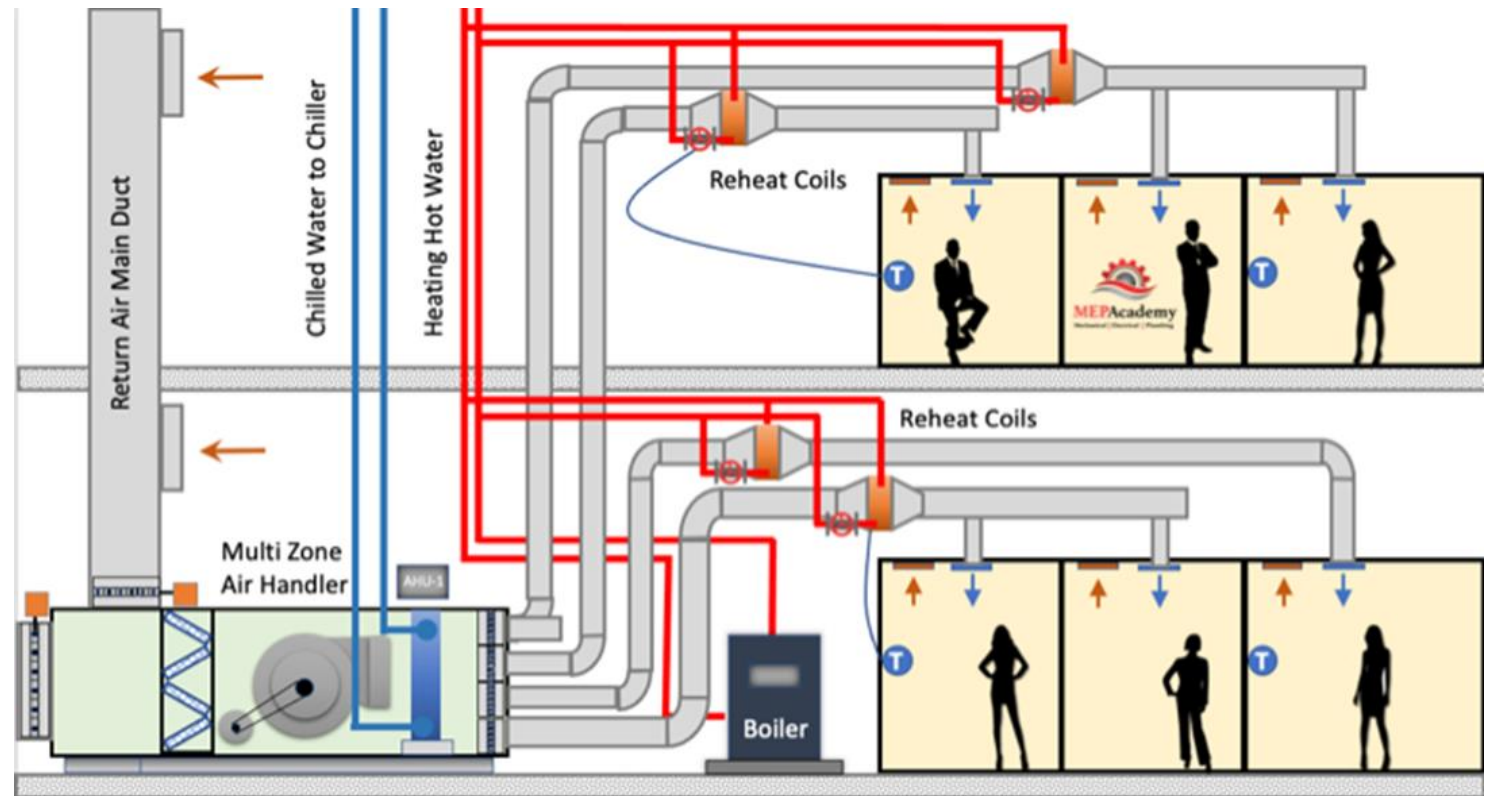
Understanding HVAC system components and operation

Package AC Systems



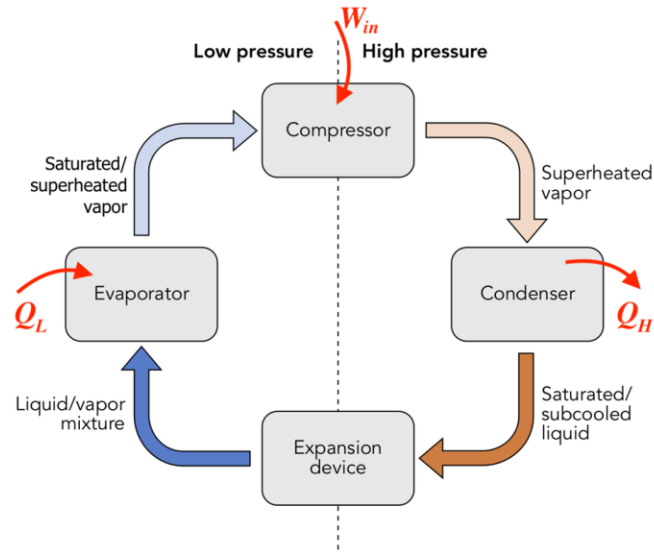
Understanding HVAC system components and operation

VAV Systems

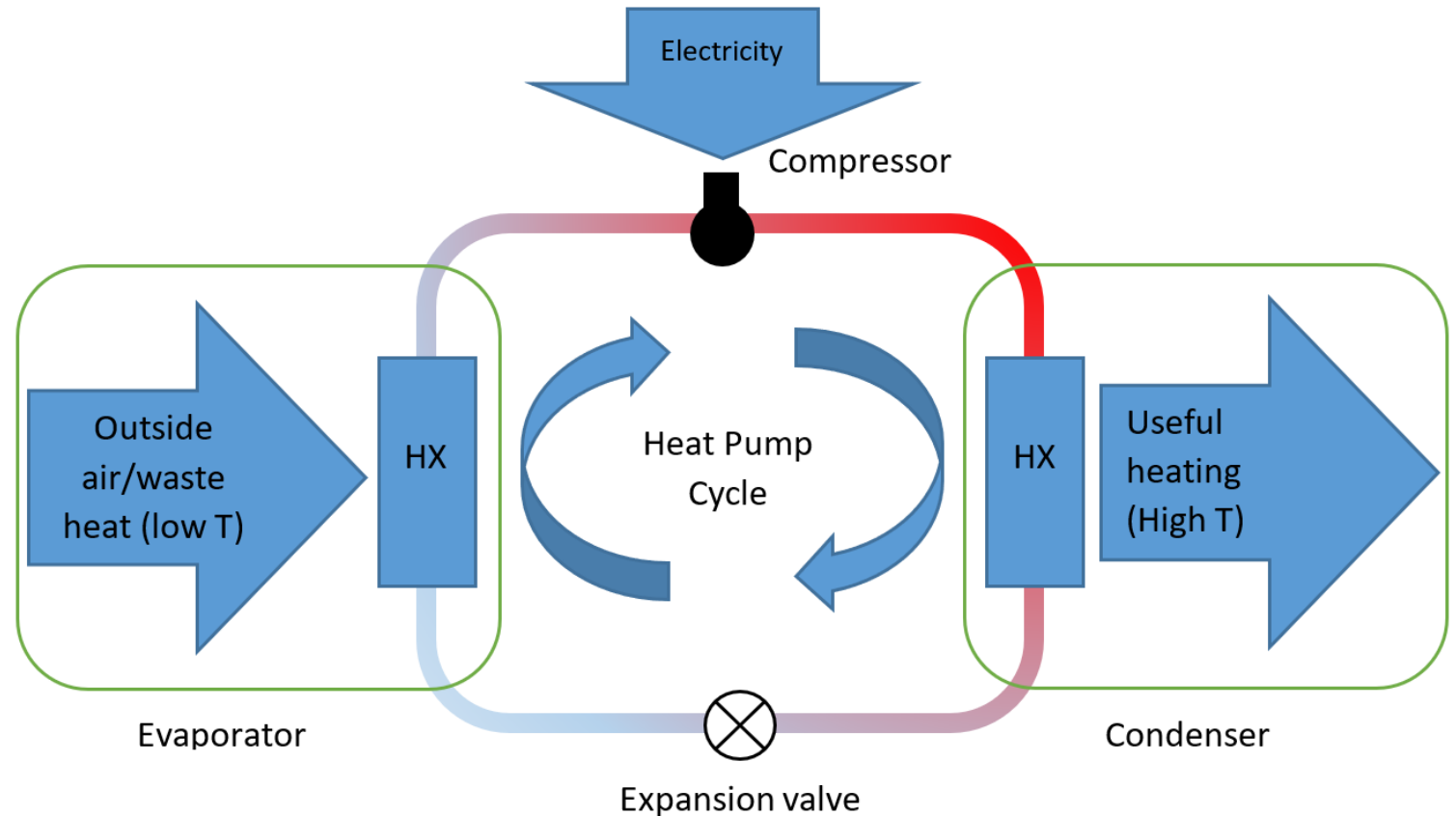


HEAT PUMP OPERATING PRINCIPLES

Heat Pump Definition

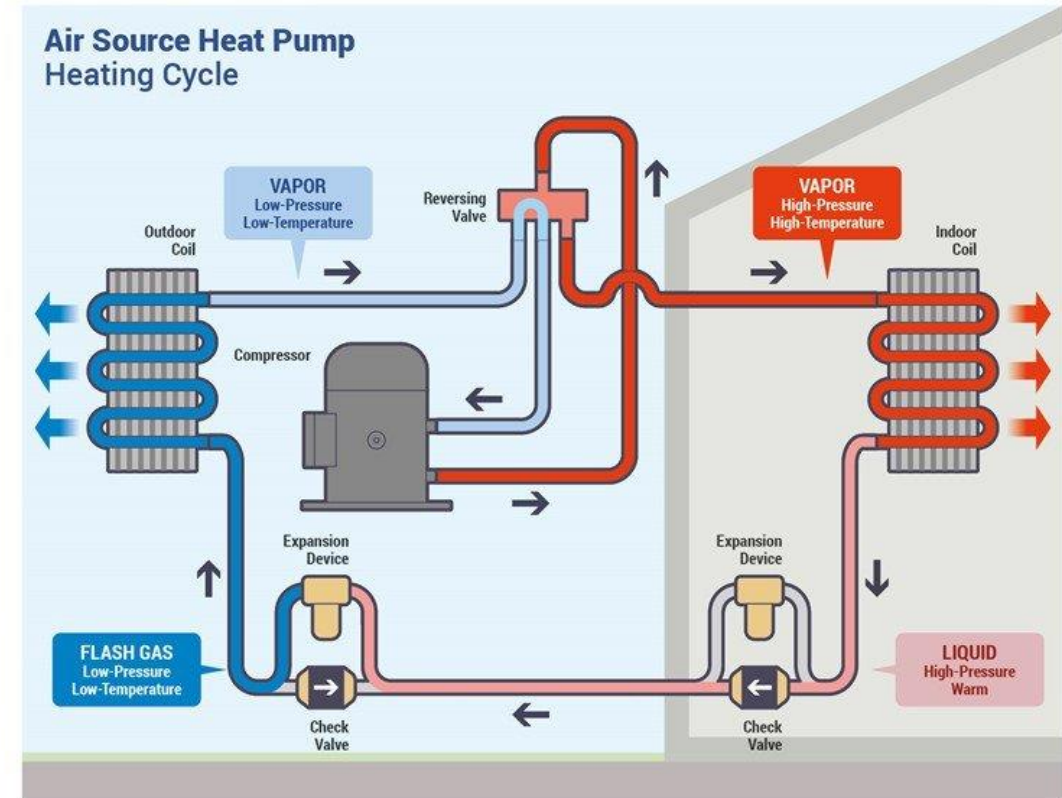
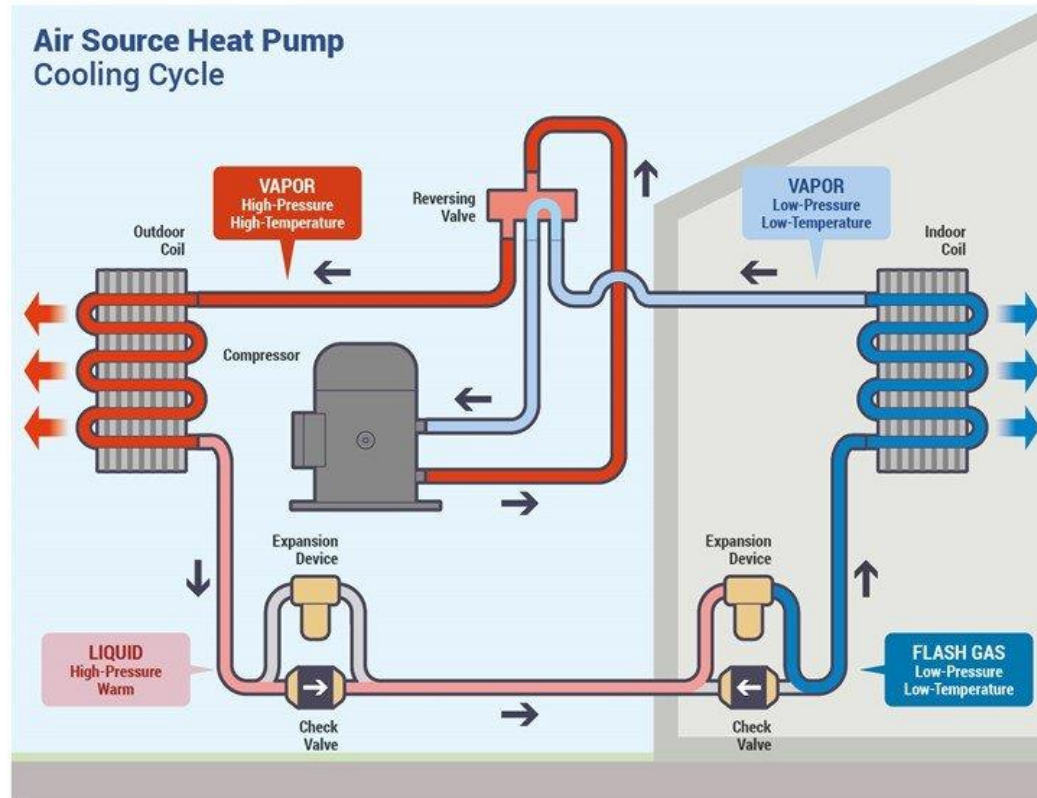


Reversible Heat Pump





Heat Pump Seasonal Operation





Heat Pump Water Heaters



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OVERVIEW OF HEAT PUMPS



Heat Pump Overview

- Heat Pump Types and Sizes
 - Small systems (.5 to 2 tons)
 - Window Units
 - PTAC/PTHP
 - Medium size systems (1.5-7 tons)
 - Splits vs package
 - Multi-head systems
 - VRF/VRV
 - Large systems (>5 tons)
 - Rooftop package, single zone CAV
 - VAV systems



Small Window and Wall Units



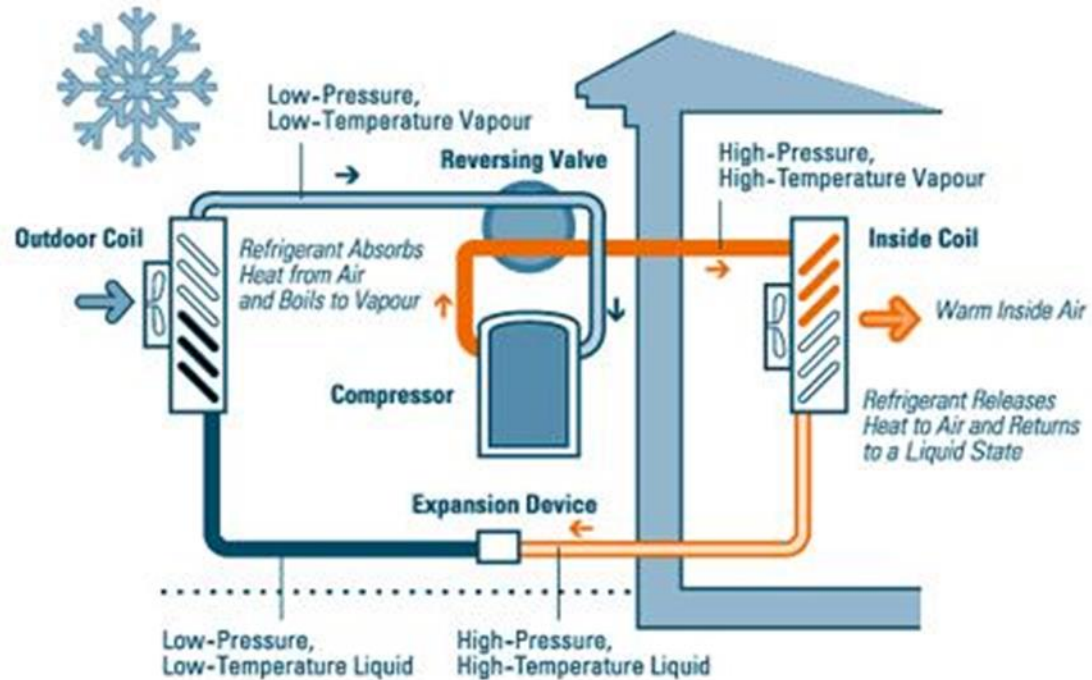


Split Heat Pump Units

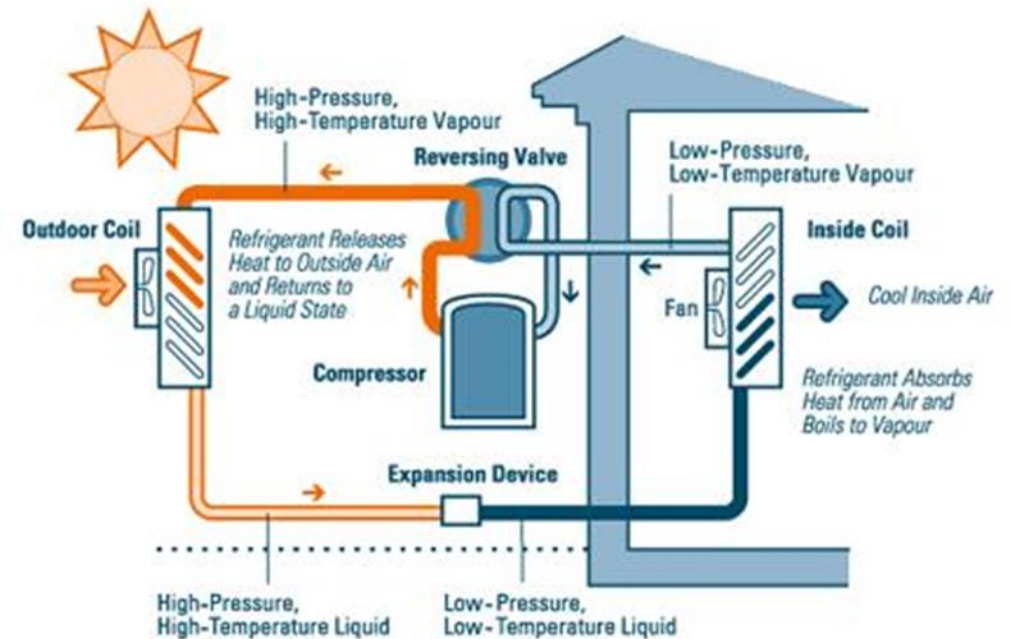




Split System Heat Pump



Air-source heat pump during heating cycle



Air-source heat pump during cooling cycle

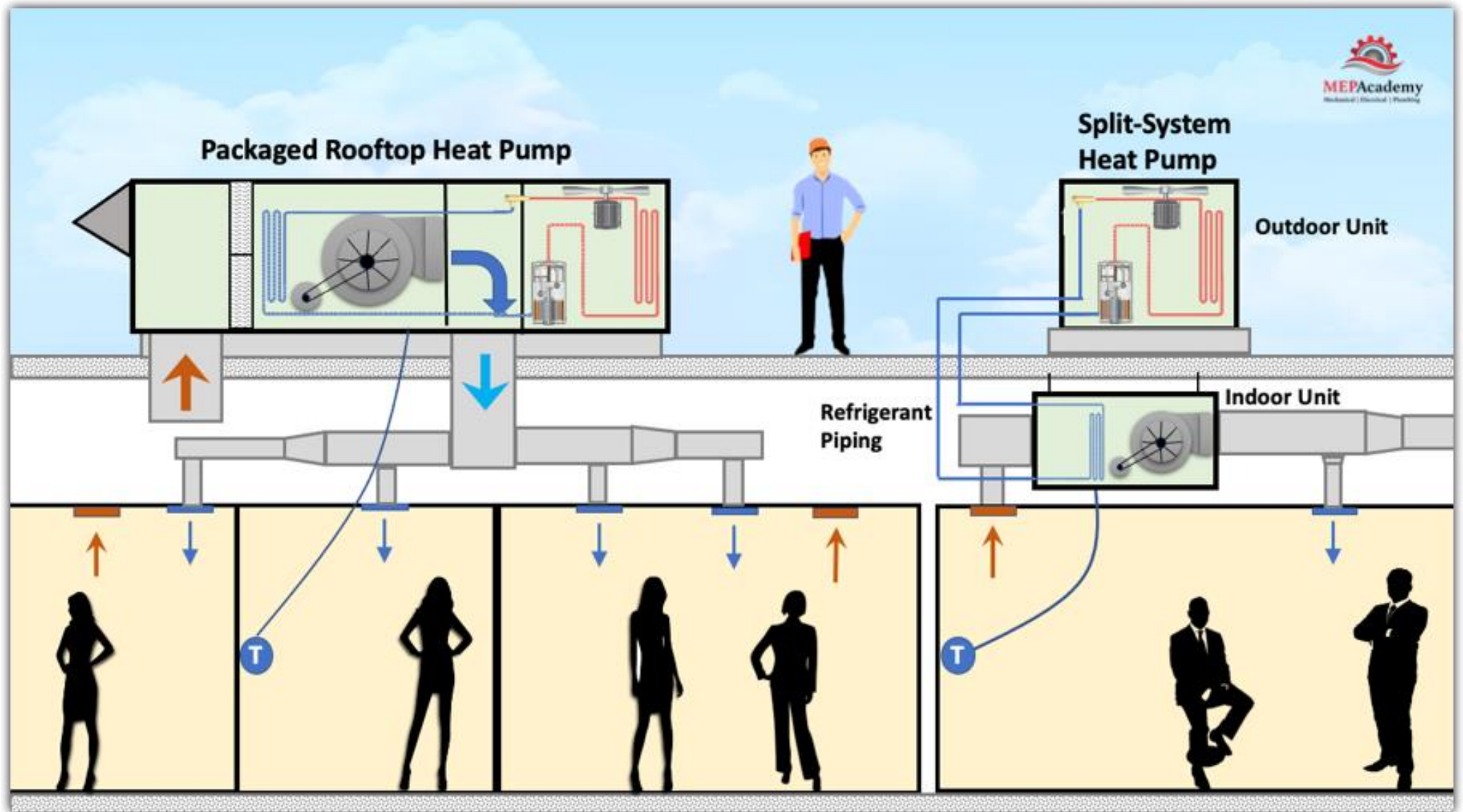


Mini-Splits and Multi-Zone





Package vs Split Heat Pumps





Package Heat Pump





VRV and VRF systems



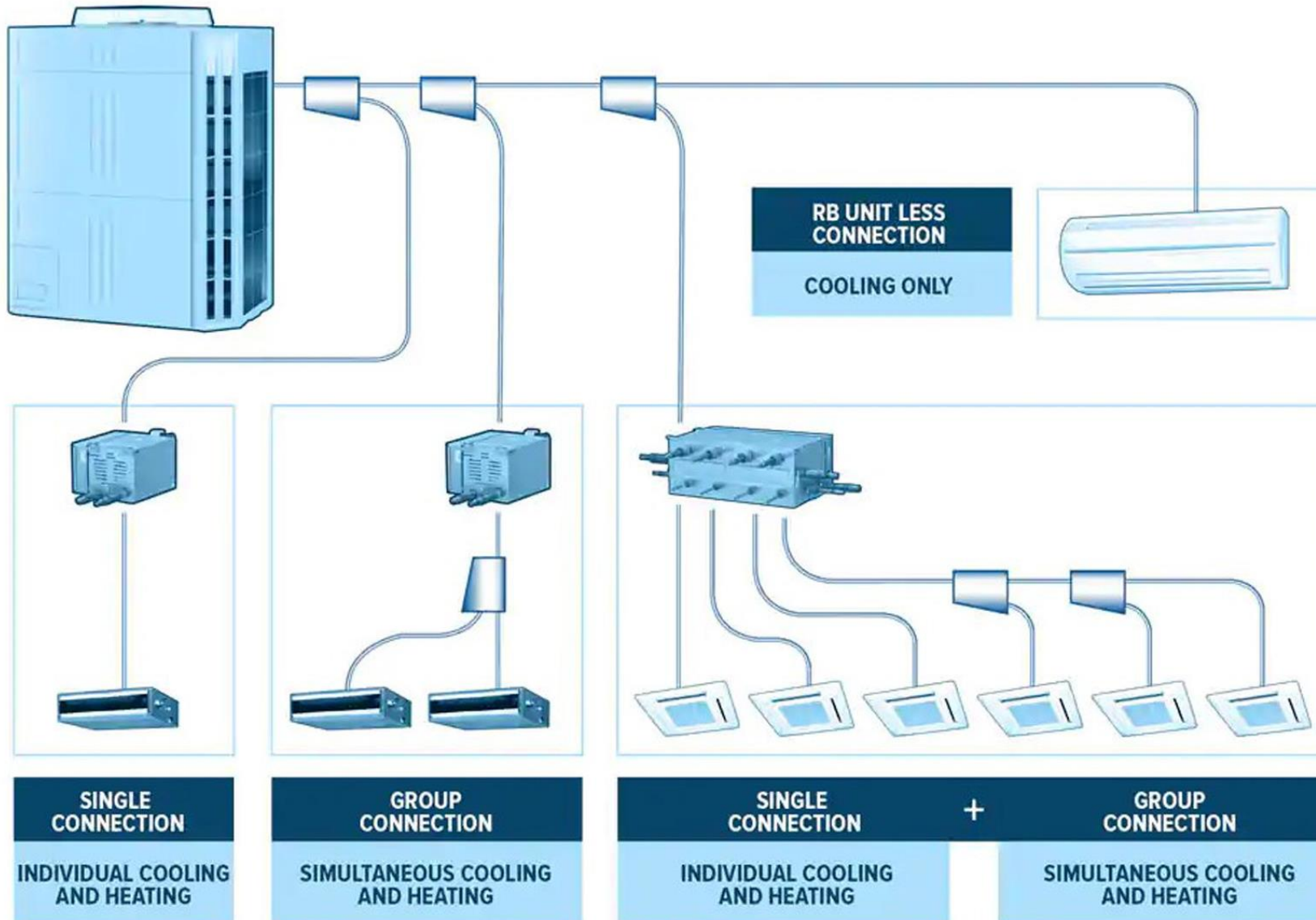
VRF Systems

VRV/VRF





VRF and Energy Optimization



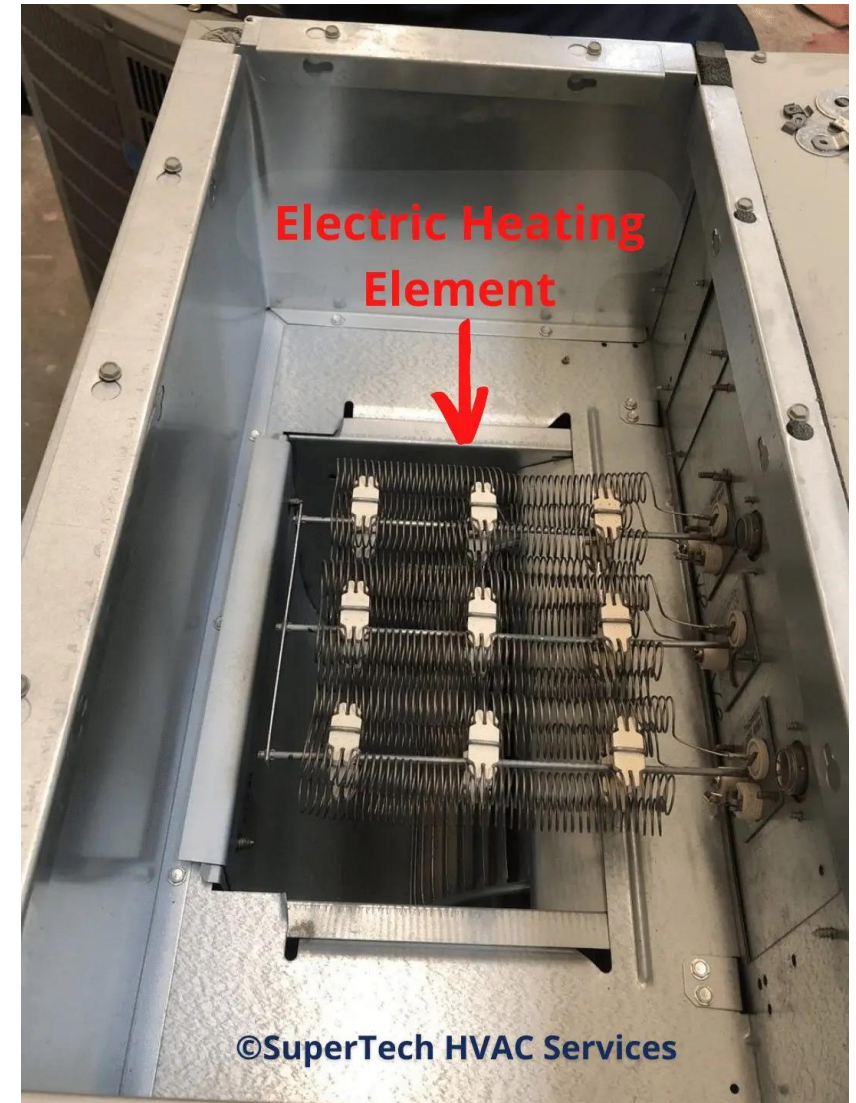
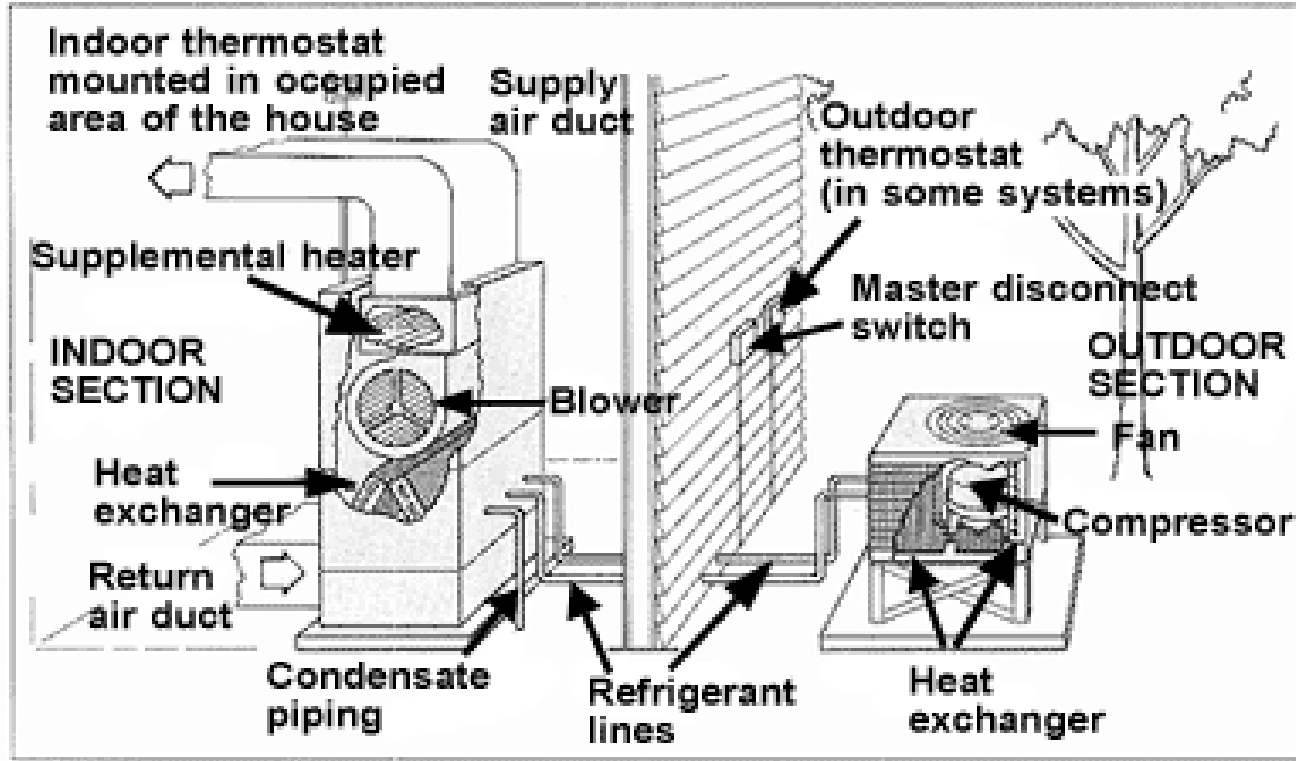


Large Rooftop Package Units





Supplemental Heat



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EFFICIENCY, SAVINGS, AND REBATES



Rebate Structure and Savings for Heat Pumps

- ✓ \$650/ton
- ✓ Cap <65kBTU
 - Baseline: 14 SEER
 - Tiers: 15, 16, 17 and 18 SEER
- ✓ Cap 65-134 kBTU
 - Baseline: 11 EER
 - Tiers: 15 and 16 IEER
- ✓ Cap 135-239 kBTU
 - Baseline: 10.8 EER
 - Tiers: 14.5 and 15.5 IEER
- ✓ Cap 240 – 760 kBTU
 - Baseline: 9.8 EER
 - Tiers: 13.5 and 14.0 IEER
- ✓ Rebates stay the same, but savings increases, and payback is shorter, as you go up the tiers.

CR Strategies for Improving HVAC Efficiency

✓ Low Efficiency Systems

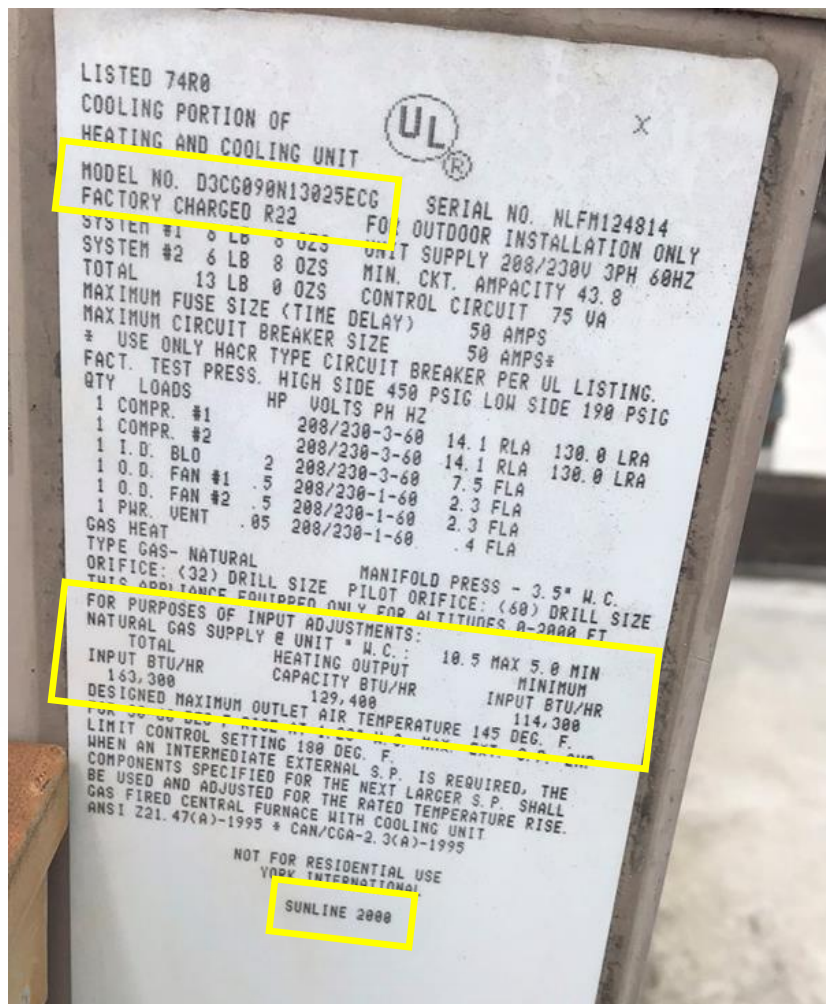
- Age
- Condition
- Initial EER/SEER/HPSF
- Refrigerant Type

✓ High Efficiency Systems

- ENERGY STAR, EER, IEER, EER2, SEER, HPSF, HSPF2, COP, etc
- Hi-Efficiency Motor
- Compressor Choice
- Refrigerant Choice
- Expansion Devices

CR Strategies for Improving HVAC Efficiency

✓ Low eff vs Hi Eff



AC SEER ratings & energy savings

10 SEER existing AC efficiency

NEW EFFICIENCY	EXPECTED ELECTRICITY SAVINGS
SEER 13	23%
SEER 16	38%
SEER 19	48%
SEER 22	55%
SEER 25	58%

12 SEER existing AC efficiency

NEW EFFICIENCY	EXPECTED ELECTRICITY SAVINGS
SEER 13	8%
SEER 16	25%
SEER 19	37%
SEER 22	46%
SEER 25	50%

14 SEER existing AC efficiency

NEW EFFICIENCY	EXPECTED ELECTRICITY SAVINGS
SEER 16	13%
SEER 19	26%
SEER 22	36%
SEER 25	42%

Table I-1. Amended Energy Conservation Standards for Small, Large, and Very Large Commercial Package Air Conditioning and Heating Equipment

Equipment Type	Heating Type	Proposed Energy Conservation Standard	Compliance Date
Small Commercial Packaged AC and HP (Air-Cooled) – ≥65,000 Btu/h and <135,000 Btu/h Cooling Capacity	AC	Electric Resistance Heating or No Heating	12.9 IEER January 1, 2018
			14.8 IEER January 1, 2023
		All Other Types of Heating	12.7 IEER January 1, 2018
	HP		14.6 IEER January 1, 2023
		Electric Resistance Heating or No Heating	12.2 IEER 3.3 COP January 1, 2018
			14.1 IEER 3.4 COP January 1, 2023
		All Other Types of Heating	12.0 IEER 3.3 COP January 1, 2018
			13.9 IEER 3.4 COP January 1, 2023



Impact of Efficiency on Projects

	Electric	Gas	Estimated		GHG	Equivalent	
	Savings	Savings	Energy Cost	Incremental	Reduction	Gallons of	Estimated
Efficiency	(kWh)	(Therms)	Savings (\$/yr)	Cost (\$)	(MT CO2e)	Gas	Incentive (\$)
15 SEER	-300.5	111.0	\$ 202	\$ 1,738	0.588	66.5	\$ 3,250
16 SEER	442.0	111.0	\$ 388	\$ 1,833	0.588	66.5	\$ 3,250
17 SEER	605.0	111.0	\$ 429	\$ 3,448	0.588	66.5	\$ 3,250
18 SEER	750.0	111.0	\$ 465	\$ 4,903	0.588	66.5	\$ 3,250

HEAT PUMP BENEFITS AND CHALLENGES

Heat Pump Benefits and Challenges

Heat Pump Benefits

- Adding cooling
- Lower Energy Bills
- Carbon Footprint Reduction
- Eliminate Gas Service

Heat Pump Challenges

- Adding cooling = More load, possible electrical service upgrade
- VAV Systems and Boiler Skids
- Cold Climate Operation
- Supplemental Heat Impact

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QUESTIONS?

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